

**Office of National Marine Sanctuaries/National Centers for Coastal Ocean
Science Long-term Agreement (ONMS/NCCOS LTA)**

**2004 Annual Liaison Report on Existing and Potential ONMS/NCCOS
Collaborative Studies at the Olympic Coast National Marine Sanctuary
(OCNMS)**



Photos courtesy of OCNMS

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1. Introduction

A partnership between the National Centers for Coastal Ocean Science (NCCOS) and the Office of National Marine Sanctuaries (ONMS) was initiated in 1999 to provide a stronger and more effective science base for managing NOAA's National Marine Sanctuaries. Under this partnership, NCCOS's role is to work with ONMS to conduct research aimed at addressing sanctuary management needs and to help apply this and related information in the development and implementation of effective management plans. The following four research priorities are to be the focus of this effort over the next several years: (1) baseline characterizations of sanctuary resources; (2) monitoring for potential environmental changes; (3) "anticipatory science" to develop and test new technologies for monitoring the health of these systems; and (4) special studies to address specific critical issues that may develop. Research liaison positions have been established within NCCOS to help facilitate this process for each of NOAA's National Marine Sanctuaries. NCCOS liaison activities at the Olympic Coast National Marine Sanctuary (OCNMS) began in spring 2003. Each year, as part of the partnership process, the NCCOS liaison and ONMS research coordinator will be working together to assess current research gaps and needs relative to the sanctuary's management goals, and to make recommendations for how the partnership can be leveraged to help address these needs. The purpose of the following report is to provide such an assessment for the FY04 annual reporting period.

2. Sanctuary Overview

The OCNMS, one of 13 National Marine Sanctuaries, covers over 2500 nm² of ocean waters off Washington State's Olympic Peninsula coastline (Figure 1). Sanctuary waters extend from the coastline to an average of 30 nm offshore and span 117 nm north to south, stretching from the United States/Canada border to the Copalis River. Its offshore boundaries roughly follow the 200 m isobath, but also include three submarine canyons: Juan de Fuca Canyon, an ancient river valley extending southwestward from Cape Flattery at the sanctuary's northern end (with depth of about 930 m at the outer edge); the Quinault Canyon off the Quinault River (about 1500 m deep); and the Nitinat Canyon at the sanctuary's extreme northwest corner (about 500 m deep). Within these boundaries is a diverse array of habitats including wave-beaten rocky shores, sandy beaches, offshore islands (870 of them), underwater kelp forests, areas of ocean upwelling, deep-sea canyons, submerged rocky reefs, and vast expanses of open sandy seafloor. These habitats, in turn, support a tremendously wide variety of marine flora and fauna, including many commercial, recreational, and protected species. As examples, the OCNMS supports one of the world's most diverse kelp/algal communities, is home to one of the largest bald eagle populations in the lower 48 states, is a critical link in the "Pacific flyway" migratory path for other seabirds, and provides habitat for one of the most diverse assemblages of marine mammals in North America. Twenty-nine species of marine mammals (including familiar ones such as harbor seals, gray whales, dolphins, and sea otters) reside or migrate through the sanctuary. Unique deepwater coral-sponge assemblages also are believed to exist in outer portions of the sanctuary. The sanctuary also is rich in cultural resources, with over 150 documented historical shipwrecks and a strong Native American legacy. Four Native American tribes — the Makah, Quileute, Hoh, and Quinault — live currently along the Olympic coast and bring to life cultural traditions passed down from thousands of years.



Figure 1. Map of Olympic Coast National Marine Sanctuary.

The OCNMS was designated as a national marine sanctuary in 1994. The overall goal of the sanctuary is to conserve, protect, and enhance its natural and cultural resources through effective research and educational programs, and by encouraging compatible commercial and recreational uses. Certain activities are prohibited within the sanctuary in order to help protect its resources (Table 1).

Table 1. Prohibited activities within the Olympic Coast National Marine Sanctuary.

- Exploration or development of oil and other mineral resources
- Moving, removing, or injuring historical or cultural resources
- Discharging or depositing any material
- Altering the seabed or building any structures on the seabed
- Injuring or harassing marine mammals, sea turtles, and seabirds
- Flying motorized aircraft below 2,000 feet within a mile of the sanctuary's coastal boundaries and offshore wildlife refuges.

Other allowable uses include offshore transportation of commercial products, placement of underwater communication cables, commercial and subsistence fishing, and a variety of recreational activities (e.g., sport fishing, boating, wildlife observations, hiking, camping, beach combing). Major resource-management issues resulting from such uses (as well as other activities outside the sanctuary) include effects of commercial shipping traffic, hazardous material spill prevention and response, water quality in relation to land-based sources of pollution, effects of underwater cable placement on benthic resources, damage to critical habitat areas, and impacts of commercial fishing harvests. A variety of management, science, and education initiatives have been implemented to help address such issues (see Section 4). In addition, the sanctuary's protected status is augmented through partnerships with related management programs in adjacent lands, including the Olympic National Park (National Park Service), Washington Maritime National Wildlife Refuge Complex (US Fish and Wildlife Service), Seashore Conservation Area (Washington State Parks and Recreation Commission), and the Biosphere Reserve and World Heritage Site. Locations of these various managed areas and the four tribal reservations (Makah, Quileute, Hoh and Quinault) are shown in Figure 1.

3. Management Goals and Concerns

The basic management framework for the OCNMS is its 1993 Final Environmental Impact Statement/Management Plan, which can be accessed through the OCNMS website (<<http://olympiccoast.noaa.gov> >). As stated in the plan, the overarching purpose of the sanctuary is protection of its environmental and cultural resources. Thus, sanctuary goals are designed primarily to:

- Reduce threats to sanctuary resources and quality;
- Ensure that water quality is maintained at a level consonant with sanctuary designation;
- Promote public awareness of, and voluntary compliance with, sanctuary regulations and objectives, through education and interpretive programs that stress resource sensitivity and wise use;
- Encourage participation by interested agencies, tribes, and organizations in the development of procedures to address specific management concerns (e.g., monitoring and emergency-response programs);
- Ensure that research results and scientific data are made available to management agencies to improve resource-protection strategies; and
- Coordinate activities of management and regulatory agencies to resolve conflicting or duplicative regulations, policies, and enforcement procedures.

A research plan also has been developed (Bowlby et al. 2002) to provide the framework needed to establish a long-term, objective science-based strategy for evaluating ecosystem health and implementing effective management programs. The key objectives of this Science Framework (OCNMS 2003) are to:

- Compile existing data (and metadata) to describe the ecosystem and/or its components and provide baseline information;
- Promote continual information exchange among universities, agencies, and non-governmental organizations undertaking research in the sanctuary;
- Establish procedures that ensure that projects are responsive to management concerns and that research results contribute to resource protection and management;
- Encourage multidisciplinary studies that link research efforts in the coastal, nearshore, open ocean, and deep sea ecosystems;
- Coordinate data collection on the physical, chemical, geological, biological and cultural resources and processes of the sanctuary in order to target data gaps, to maximize the effectiveness of collaboration with other trustee agencies and tribes, and to avoid duplication of effort;
- Initiate a monitoring program to assess environmental changes due to natural and human processes;
- Identify potential environmental influences from both human activity and natural phenomena;
- Encourage research that examines biodiversity within the habitats of the sanctuary;
- Ensure that research activities do not harm or diminish resources within the sanctuary;
- Incorporate research results into an interpretive/education program in a format useful for the general public; and
- Evaluate, on a regular basis, the effectiveness and efficiency of the research program with regard to its integration with resource protection, management, and educational objectives.

Under the Science Framework, research projects are encouraged within the following categories:

- Reviews of existing information on environmental and cultural resources, and historical management practices, as a basis of comparison to results of future studies;
- Baseline assessments/inventories and follow-up monitoring studies to document status and trends in sanctuary resources and uses;
- Experimental studies to understand processes and to determine the causes and effects of specific environmental events and changes;
- Modeling activities (numerical simulations, ecosystem models, and statistical models) to enhance interpretive and predictive abilities; and
- Information management activities to enhance the management and dissemination of program results.

Examples of relevant research topics under each of these project categories are listed in Table 2 (taken from the 2003 Science Framework).

Also, under this framework, research and monitoring activities are directed at the following types of potential environmental stressors:

- Non-point source pollution (e.g., runoff of soil, organic matter, and chemical and bacterial contaminants; runoff from roads and bridges; and atmospheric deposition of volatilized pollutants);
- Point-source pollution (e.g., discharge of chemical and organic pollutants from sewage outfalls, dredge spoils disposal, and ocean dumping);

- Commercial activities (e.g., dredging, aquaculture, kelp harvesting, commercial fisheries, underwater fiber-optic cable installation, and ecotourism);
- Recreational activities (e.g., sport fishing, boating, wildlife observations, hiking, tidepooling, camping.); and
- Unpredictable anthropogenic events (e.g., hazardous material or petroleum spills, ship groundings, and introduction of non-indigenous species).

4. Current Sanctuary Projects

A list of current research projects (with contact information) is provided in Table 3. The many examples that are included illustrate the wide range of ongoing work on important resource issues facing the sanctuary.

5. Research Gaps and Future Needs

Table 2 lists examples of relevant research topics at OCNMS for various types of projects, based on material presented in the sanctuary's 2003 Science Framework. The framework further identifies the following topics as high priorities for future work relative to the various project categories:

Inventorying and Monitoring

- Increased efforts of OCNMS and its partners to learn more about the physical oceanography of the area by expanding remote-sensing data collection using buoy arrays and satellite imagery;
- Future use of remotely operated vehicles (ROVs), submersibles, and acoustic-habitat surveys to enhance monitoring of deep-sea environments;
- Increased monitoring of selected bird, mammal, and fish species and their trophic dynamics;
- Rapid assessment of invasive species;
- More intensive monitoring of deep-water benthic communities; and
- Long-term monitoring in support of zoning considerations pertaining to the use of marine protected area (MPA) designations as a potential management tool for preserving biodiversity, sustaining fisheries, and preserving cultural artifacts.

Experimental Studies

- Developing a better understanding of the role of refugia in sustaining marine populations;
- Developing a better understanding of how various oceanographic conditions affect ocean productivity and trophic dynamics;
- Evaluating the role of subtidal kelp assemblages as fish-rearing habitat;
- Studies to determine why certain seabird and groundfish populations are declining;
- Studies to determine the effects of chemical contaminants on sea otters; and
- Studies to understand sources and sinks of larvae and the role of ocean currents in distribution and dispersal.

Modeling

- Better models of currents and ocean events (e.g., severe storms, sea level rises, El Nino-southern oscillations) as tools to help in predicting ocean conditions and productivity, and improving estimates of oil-spill trajectories; and

- Realistic models of the population dynamics of commercial fish, marine mammal, and bird populations in order to support sound management decisions regarding the long-term health of such key resources.

Information Management

- Tools and initiatives to help OCNMS fulfill its vision of serving as a clearinghouse for information and communication surrounding marine research within the sanctuary; and
- Initiatives to enhance public awareness and appreciation of the diverse and tremendously valuable resources within the sanctuary.

An additional detailed analysis of information needs for the OCNMS was performed in 2001, as part of a system-wide evaluation of all 13 National Marine Sanctuaries. Results of this national workshop (Gittings et al. 2002; also see <http://sanctuaries.nos.noaa.gov/library/national/science_eval.pdf >) suggested that the following four management issues warrant the greatest increase in research activity for the OCNMS:

- Assessment of fishing/harvesting pressures (e.g., comparison of potential effects of bottom trawling in areas of high to low fishing intensity);
- Development of information to support zoning considerations: evaluation of condition and trends of biological resources in critical habitats (e.g., areas inhabited by sensitive long-lived species, such as deep-water coral/sponge assemblages);
- Assessment of living marine resources (including spatial and temporal patterns and measures of ecological fitness); and
- Restoration/rehabilitation (evaluation of measures to restore or enhance recovery of natural resources impacted by human activity).

The first two of these issues were identified as high-priority topics for four of the five west-coast National Marine Sanctuaries, thus suggesting multiple-sanctuary needs common to the region. All four of these higher-priority issues, and especially the first two (given their broader regional significance) should be regarded as important future research areas to pursue.

An additional priority for the OCNMS will be to continue working on important ongoing projects, such as those listed in Table 3. As just two examples, research efforts of the OCNMS will continue to be devoted to the following ongoing studies in the upcoming year: (1) offshore monitoring of the potential ecological effects of underwater fiber-optic cable installations (which also include areas of high and low fishing intensities), and (2) marine mammal and seabird surveys and habitat characterization. Both of these studies relate to critical issues identified in the above NMS needs analysis. NCCOS science that assists or builds upon such ongoing initiatives within the sanctuary may be beneficial as well.

A final priority is research that can be incorporated into overall system-wide monitoring strategies for sanctuaries, and thus is contributing information to help address broader questions of regional and national relevance. Examples of such questions might be, “How do conditions of sediment and water quality compare among sanctuaries across the Nation,” or “How do such conditions in sanctuaries compare to non-sanctuary waters regionally and nationally?” In order to address such questions, there is a need for sanctuaries to engage in efforts to make consistent measurements of key indicators and to bring this information together into integrated nationwide databases. Such recommendations were made in the 2000 reauthorization of the National Marine Sanctuaries Act, and supported through the findings of a recent NMS workshop held in 2002 to discuss the development of a system-wide monitoring framework (NMSP 2002). As a follow-up to the workshop, a framework for System-Wide Monitoring (SWiM) of the sanctuaries has now been developed (NMSP 2004).

6. Overview of NCCOS Science Capabilities Available to Assist With Sanctuary Needs

Detailed descriptions of the National Centers for Coastal Ocean Science (NCCOS) can be obtained through the NCCOS website and associated links at <<http://www.nccos.noaa.gov>>. Highlights of this information (extracted from the website) are presented here as a brief overview of NCCOS programs and capabilities that can be leveraged through the NCCOS-NMS partnership to help the OCNMS fill data gaps and future management needs.

NCCOS, with headquarters in Silver Spring MD, was formed as a part of the National Ocean Service in March 1999 as a means of consolidating its coastal research capabilities. Five research centers exist at present under NCCOS: the Center for Sponsored Coastal Ocean Research (CSCOR) in Silver Spring, MD; the Center for Coastal Monitoring and Assessment (CCMA) also in Silver Spring, MD; the Center for Coastal Fisheries and Habitat Research (CCFHR) in Beaufort, NC; the Center for Coastal Environmental Health and Biomolecular Research (CCEHBR) with facilities both in Charleston, SC and Oxford, MD; and the Hollings Marine Laboratory (HML) in Charleston, SC. Collectively across these centers, NCCOS offers a broad range of complementary capabilities in disciplines such as marine ecology and biology, fishery ecology and management, marine pathology, microbiology, molecular and cellular biology, genetics, biochemistry, ecotoxicology, environmental chemistry, marine forensics, remote sensing, biogeography, ecological statistics, GIS analysis, environmental risk analysis, coastal-resource management, and information technology.

NCCOS conducts and sponsors a variety of monitoring, assessment, research, and technical-assistance projects to support the coastal stewardship role of NOS and to help NOAA achieve its related national strategic goal of sustaining healthy coastal ecosystems. The combined capabilities listed above are available to address a broad range of environmental issues pertinent to this mission. Key goals are to:

- Deliver high-quality science in a timely and consistent manner using strong, productive partnerships;
- Develop and maintain relevant research, long-term data collection and analyses, and forecasting capabilities to support people who manage and use coastal resources;
- Build capacity in the private, local, and state sectors by transferring technology and by providing technical assistance and knowledge; and
- Conduct anticipatory science needed to manage potential impacts of multiple stresses on coastal ecosystems.

In addressing these goals, NCCOS currently is focusing its science on five major categories of ecosystem stress:

- Climate change,
- Extreme natural events,
- Pollution,
- Invasive species, and
- Land and resource use.

Understanding how these complex issues affect the quality and quantity of coastal habitats, and the diversity, abundances, and integrity of component living resources, is vital for the effective management of our Nation's coastal ecosystems. NCCOS is attempting to develop this knowledge by focusing its efforts currently on four ecosystem categories: coral reefs, estuaries, National Estuarine Research Reserves, and National Marine Sanctuaries. The latter commitment to working within sanctuaries has been formalized through the ongoing ONMS/NCCOS partnership.

NCCOS also provides a capability to perform Integrated Assessments (IAs) as a strategy for addressing coastal ecosystem effects with respect to any particular combination of the above stressor and ecosystem categories. Integrated assessments consist of the following steps: (1) documenting status and trends of ecosystem and/or cultural resource conditions, (2) relating such trends to their environmental or economic causes and consequences, (3) predicting outcomes of alternative management actions, and (4) providing guidance for implementing the alternatives. A successful IA is one that is responsive to policy-relevant questions, includes peer review and public participation, is broadly integrative and synthetic, is based on high-quality existing information, and is predictive. The IA approach provides a science-based framework for determining the source and scale of an existing environmental problem and evaluating various alternative management strategies. NOS is currently using an IA approach to examine the effectiveness of the existing network of Marine Protected Areas (MPAs) along the coasts of Washington, Oregon, and California in meeting goals of Executive Order #13158 (i.e., preserving biodiversity, sustaining fisheries, and preserving cultural artifacts).

Each NCCOS center provides a unique set of capabilities that could be utilized to help support sanctuary research and educational needs. These Centers and their corresponding programs include:

Center for Sponsored Coastal Ocean Research (CSCOR). The center is located in Silver Spring, Maryland. CSCOR operates the Coastal Ocean Program (COP), which is a federal-academic partnership providing predictive capabilities for managing coastal ecosystems. COP supports research in three areas: coastal fisheries ecosystems, cumulative coastal impacts, and harmful algal blooms/eutrophication. For further information contact the CSCOR website at <<http://www.cop.noaa.gov>>.

Center for Coastal Monitoring and Assessment (CCMA). The center is located in Silver Spring, Maryland. CCMA monitors, surveys, and assesses coastal environmental quality, habitats, and resource distribution. CCMA also is home of the National Status and Trends Program (NS&T), which conducts long-term contaminant monitoring at more than 350 estuarine and coastal sites around the country. Information from the Center's monitoring and assessment studies are synthesized and evaluated to determine the impacts of contaminant exposure and changes in coastal habitats on the distribution and abundance of living marine resources. CCMA's major program areas are in biogeographic characterization, bioeffects monitoring, and remote sensing. For further information contact the CCMA website at <<http://ccmaserver.nos.noaa.gov>>.

The Center for Coastal Fisheries and Habitat Research (CCFHR). The center is located in Beaufort, North Carolina. CCFHR consists of the following teams conducting a combination of laboratory and field research: Fisheries Oceanography and Ecology; Plankton Ecology and Physiology; Applied Spatial Ecology and Habitat Characterizations; Fish Ecology, Habitat Restoration, and Contaminants; and Coastal and Estuarine Ecosystem Restoration Research. Key areas of research include: coastal habitat utilization and restoration, fish ecology, chemical and physiological processes, ecology and oceanography of harmful algal blooms, population dynamics of reef and coastal fish species, and marine protected species (sea turtle and marine mammal). For further information contact the CCFHR website at <<http://shrimp.ccfhrb.noaa.gov>>.

Center for Coastal Environmental Health and Biomolecular Research (CCEHBR). The center has laboratories both in Charleston, South Carolina and Oxford, Maryland. CCEHBR provides scientific information required to resolve important issues related to the health of coastal ecosystems, environmental quality, and related public health impacts. Chemical, biomolecular, microbiological, histological, toxicological, and ecological research tools are used to characterize the health of coastal ecosystems, including living resources and their associated habitats, and to assess and predict the causes

and consequences of various human and natural stressors on the integrity of these resources. Major research areas include: marine biotoxins and harmful algal blooms, marine ecotoxicology, marine pathology, marine biotechnology and genetics, coral health, invasive species management, health of marine protected species (sea turtles and marine mammals), marine forensics, environmental risk analysis, and coastal ecology. For further information contact the CCEHBR website at <<http://www.chbr.noaa.gov>>.

Hollings Marine Laboratory (HML). The center, named after Senator E. Fritz Hollings, is located in Charleston, South Carolina. HML, which opened recently in 2002, is a newly established multi-institutional, multi-disciplinary laboratory providing science and biotechnology applications to sustain, protect, and restore coastal ecosystems, with emphasis on linkages between the environment and human health. Major research areas include: environmental/analytical chemistry, marine genomics, molecular biology and physiology, contemporary use of pesticides, ecotoxicology, proteomics, and aquaculture production and disease. HML is co-occupied by several partnering institutions including NCCOS, South Carolina Department of Natural Resources, University of Charleston, National Institute of Standards and Technology (NIST), and the Medical University of South Carolina. It is governed by an Executive Board, a Science Board, and several operational committees, under the leadership of a NOAA/NCCOS laboratory director. For further information contact the HML website at <<http://www.nccos.noaa.gov/about/hml.html>>.

7. Summary of Ongoing and Planned Partnership Activities for OCNMS

FY04 Progress

EMAP West-Coast Shelf 03 Survey. As mentioned above, NCCOS liaison activities at OCNMS began in spring 2003. Initial collaborations have resulted in two significant accomplishments. The first is the incorporation of the sanctuary as a component of a multi-agency partnership effort by NOAA (including NCCOS, NMSP, OMAO, and NMFS), EPA, western U.S. states (WA, OR, and CA), Moss Landing Marine Laboratories (MLML), and the Southern California Water Resources Research Project (SCWRRP) to conduct a comprehensive survey of ecological conditions in continental shelf waters (30-120 m) from the Canadian to Mexican borders. Field work for this project was completed in June 2003. The study design, based on EMAP national monitoring protocols, included consistent sampling of multiple ecological indicators across a probability-based array of random sampling sites. As a result, measures of benthic community structure, chemical contaminants in sediments and biota, nutrients and chlorophyll concentrations in the water column, and basic habitat characteristics (DO, pH, salinity, depth, temperature, sediment TOC and grain size) were obtained at a total of 30 stations within the OCNMS, in addition to numerous other sites along the west coast of the U.S. (including sites in the four California sanctuaries). Data will be used to assess conditions within the OCNMS with respect to these key environmental variables, and to examine patterns in comparison to the broader surrounding shelf regions. This project addresses several of the priority management issues and information needs identified above (Section 5) including, among others, information on the patterns and conditions of living marine resources and system-wide monitoring. A Final Report is expected in FY06.

Deep-Sea Coral/Sponge Study. The second accomplishment has been the initiation of a collaborative effort between OCNMS and NCCOS/CCEHBR to evaluate critical offshore habitats and their susceptibility to fishing/harvest impacts in the sanctuary. The offshore shelf and canyon habitats of the OCNMS are areas of high primary productivity and biodiversity that support extensive groundfish fisheries. Recent acoustic surveys conducted in these waters have indicated the presence of hard-bottom substrates believed to harbor unique deep-sea coral and sponge assemblages. Such fauna are

often associated with shallow tropical waters, however an increasing number of studies around the world have recorded them in deeper, cold-water habitats in both northern and southern latitudes. These habitats are of tremendous value as sites of recruitment for commercially important fishes. Yet, ironically, studies have shown how the gear used in offshore demersal fishing, as well as other commercial operations on the seafloor (such as cable trenching), can cause severe physical disturbances to resident benthic fauna. Due to their exposed structure, slow growth and recruitment rates, and long life spans, deep-sea corals and sponges may be especially vulnerable to such disturbances, requiring very long periods to recover. Potential effects of fishing and other commercial operations in such critical habitats, and the need to define appropriate strategies for the protection of these resources, have been identified as a high-priority management issue for the sanctuary (Gittings et al. 2002).

To begin addressing this issue, a team of OCNMS, NCCOS, and partnering scientists conducted an initial pilot survey in June 2004 to explore for the presence of deep-sea coral/sponge assemblages at the OCNMS and to look for evidence of potential anthropogenic impacts in these critical habitats (Hyland et al. In Review). The survey was conducted on the NOAA Ship McArthur-II using the Navy's Phantom DHD2+2 remotely operated vehicle (ROV), which was equipped with a video camera, lasers, and a manipulator arm for the collection of voucher specimens. Although the sampling coverage of this pilot effort was limited, results were highly significant in demonstrating for the first time the presence of target deep-sea coral species in these waters. Patches of rare stony corals, now positively identified as *Lophelia pertusa*, were discovered on a rock ledge at 271 meters in an area where previous side-scan sonar records suggested suitable hard substrate (Fig. 2). Many individuals consisted of dead and broken skeletal remains, and a broken gorgonian (soft coral) also was observed nearby (Fig. 2). The source of these disturbances is not known. However, observations from several sites included accounts of trawl marks in sediment and derelict fishing (long line) gear. Preliminary results also suggest that these areas are important reservoirs of marine biodiversity and of value as fish habitat. Onboard examination of 18 bottom-sediment grabs (0.1 m² each) revealed infaunal species representative of 14 different invertebrate phyla. Twenty-eight species of fishes from 11 families, including 11 species of commercially important rockfishes, also were identified from ROV video footage. These initial discoveries have sparked considerable interests in follow-up studies to learn more about the spatial extent of these assemblages and magnitude of potential impacts from commercial fishing and other anthropogenic activities in the area (e.g., OCNMS Advisory Council, September 2004 resolution endorsing follow-up work). Pending funding, a follow-up survey will be conducted in June 2005 to address such goals. Results will be used to support future decision making regarding the possible need for additional conservation measures in such critical habitats of the OCNMS.

Plans and Recommended Activities for FY05 (and beyond)

1. Continuation of the shelf-wide EMAP survey of ecological conditions along the west coast, inclusive of OCNMS sites (Hyland and Bowlby with other agency partners).
2. Follow-up ROV survey of deep-sea coral/sponge assemblages at OCNMS in June 2005. The primary goal is to develop a better understanding of the spatial extent of these assemblages and magnitude of potential impacts from commercial fishing or other anthropogenic activities in the area. Shiptime is scheduled for 8 DAS on MacArthur II. (Hyland and Bowlby with other state and academic partners).
3. Continuation of interactions between the NCCOS liaison (Hyland) and OCNMS research coordinator (Bowlby) in efforts to stay abreast of OCNMS research needs and to help facilitate the responsiveness of NCCOS science to meeting such needs. Efforts will be made to optimize the efficiency of this process through routine communications and the use of tools, such as the present liaison document, to

promote the exchange of information on science capabilities, future management needs, and new ideas for research to address such needs.

4. Fostering opportunities for coordination of results of new monitoring and research projects at OCNMS (such as Activities #1 and #2 above) with those of prior studies (e.g., historical contaminant data from the NS&T program conducted by NCCOS/CCMA). Efforts to build upon ongoing projects should be encouraged as well. For example, in the process of implementing the ongoing FY04/05 study of deepwater coral/sponge assemblages (Activity #2 above), we will attempt to collect specimens of coral for Dr. Cheryl Woodley (NCCOS/CCEHBR, Charleston, SC) to supplement her ongoing studies of coral health (thus providing an opportunity to work on the development of health indicators for new cold-water species of corals).

5. Facilitation of projects to be conducted by other NCCOS investigators at OCNMS through the NCCOS/NMSP partnership. A biogeographic assessment by Clark and Monaco (of NCCOS/CCMA) is scheduled to begin in FY05, with continued funding in FY06. An initial kick-off meeting for this project was held in November 2004. Liaison assistance will be provided as needed to facilitate this and any other new projects initiated through the partnership.

8. Contacts

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Table 2. Examples of long-term research objectives at OCNMS (taken from the OCNMS 2003 Science Framework).

1. Existing Knowledge

- Information on the physical, chemical, and geological oceanography and conditions of the sanctuary (e.g., as described in the “Environmental Conditions” section of the sanctuary’s FEIS)
- Information on the living marine resources of the sanctuary and their condition, including lists of species and associated habitats (e.g., as described in the “Natural Resources” section of the sanctuary’s FEIS)
- Information on the historical and cultural resources of the sanctuary (e.g., as described in the “Cultural and Historical Resources” section of the sanctuary’s FEIS)

2. Inventorying and Monitoring

Physical Environment

- Environmental factors, such as wind, sea level, temperature, collected by coastal stations, offshore data buoys, and satellites;
- Natural erosion and sedimentation;
- Nearshore circulation and transport;
- Water-quality; and
- Sea floor features, surveyed in part, with high-resolution sea-floor mapping.

Biota

- Significant species (species federally listed under the Endangered Species Act, Marine Mammal Protection Act, Migratory Bird Treaty Act, or State listed species);
- Critical habitats for significant species (federal or state listed species)
- Harmful algal bloom;
- Changes in abundance at various life history stages of macroinvertebrates and fish;
- Invasive-species;
- Fluctuations in the distribution/abundance of marine mammal and bird populations; and
- Biodiversity.

Historical/Cultural Context

- Sport, commercial, and subsistence fishing activity;
- Status and trends of chemical contaminants;
- Status and trends of cultural and historical resources;
- Commercial vessel traffic;
- Recreational and nature observation activities;
- Anthropogenic induced erosion and sedimentation; and
- Seafloor alterations, such as fiber-optic cables and fishing-gear impacts.

3. Experimental Studies

- What are recovery patterns of algae, invertebrates, fishes, marine mammals, and birds associated with different oil-spill response strategies;
- What are the long-term effects of fishing-gear and fiber optic-cables on seafloor communities;
- What are the effects of harvest refugia on fishes and other biota;
- What are the watershed effects on sedimentation rates and circulation along nearshore ecosystems;
- What are the effects of foraging sea otters on kelp communities and fisheries; and

- What is the level of dependence of anadromous and migratory species at different life-cycle stages on various aspects of the physical and biological environment?

4. Modeling

- Interpretation of nearshore, oceanographic and ecosystem processes and their relationships to fisheries management and potential refugia;
- Prediction of the effects of boating and aircraft activity on marine mammals and birds;
- Prediction of the trajectory of unintentional discharges (such as fuel spills) into the sanctuary;
- Characterization of nearshore circulation and transport of sediment; and
- Prediction of how fluctuations in kelp habitats may influence kelp-associated species and adjacent shorelines.

5. Information Management

- Developing a database system for cataloging information;
- Creating an electronic information network to facilitate more timely and efficient information exchange (e.g., web site);
- Establishing a GIS dataset to incorporate scientific and historical/cultural information gathered within the sanctuary; and
- Incorporating the status of current research projects, results of prior research projects, and management decisions based on the outcome of these projects into the education and public-outreach programs developed for the sanctuary (e.g. web site, workshop and conference proceedings, student programs, volunteer programs, public forums, adult continuing education classes, and other related means of delivery).

Table 3. Examples of ongoing science programs within the OCNMS

Resource/Habitat	Purpose	Scope/Approach	Contact Person
Offshore Habitats (including canyons)	Document presence of deep-sea coral/sponge assemblages & assess potential effects of commercial fishing & other anthropogenic activities in such critical habitats.	ROV photography & grab sampling around hard-bottom substrates in areas of high & low commercial fishing intensity.	Jeff Hyland, NOAA/NCCOS (843/762-8652); and Ed Bowlby, OCNMS (360/457-6622, x 17).
Offshore Habitats (including canyons)	OCNMS phase of NOAA's "Sanctuary Quest" mission (2002) to increase understanding of the physical & biological characteristics of deep-sea & offshore habitats within west-coast sanctuaries.	ROV photography to characterize fish & invertebrate assemblages; marine mammal & seabird surveys to assess offshore distribution & abundance. Sampling included ROV operations in Juan de Fuca & Nitinat Canyons.	Ed Bowlby, OCNMS (360/457-6622, x17). Partnering institutions include other parts of NOAA, WA Dept. Fish & Game, & Makah Cultural & Research Center.
Offshore Habitats & Fauna	Determine potential effects of fiber-optic cable installations on the seafloor & resident fauna, & compare effects in areas of low vs. high fishing intensity (100-300 m)	Sampling of benthic infauna and sediment chemistry with grabs & cores; video surveys of epifauna with subs & ROVs; side-scan & multibeam imagery of seafloor	Mary Sue Brancato, OCNMS (360/457-6622,x20), or Ed Bowlby, OCNMS (360-457-6622, x17)
Offshore habitats	To map Sanctuary shelf and canyon habitats	Use of both side-scan sonar and high resolution multibeam bathymetry	Steve Intelmann, OCNMS (360-457-6622,x22)
Offshore habitats	To document deep-water benthic communities (50-300 m)	Use of ROV or submersibles for video surveys	Ed Bowlby, NOAA/NOS/OCNMS (360-457-6622, x17)

Offshore fish habitats	Assess fish populations associated with habitat features	Submersible surveys and habitat maps	Tom Jagielo, WDFW (360-902-2837)
Subtidal Habitats & Fauna, & Overlying Water Column	EMAP survey of status of ecological conditions of shelf waters (30-120 m) along west coast of U.S. (WA, OR, CA) inclusive of NMSs, based on multiple ecological indicators	Measures of benthic community structure, chemical contaminants in sediments & biota, nutrients & chlorophyll in water column, & basic habitat characteristics (DO, pH, salinity, depth, temperature, sediment TOC & grain size) at 30 stations within OCNMS, in addition to numerous other sites along the west coast of U.S. (including sites in the four CA sanctuaries). Probability-based, random sampling design used to support statistical estimation of spatial extent of condition relative to measured indicators	Jeff Hyland, NOAA/NOS/NCCOS (843/762-8652); or Ed Bowlby, NOAA/NOS/OCNMS (360-457-6622, x17). Other partnering institutions include EPA, NOAA/NMFS, NOAA/OMAO, west coast states (WA, OR, CA), MLML, & SCWRRP.
Subtidal Habitats & Fauna	Develop baseline data for habitat characterization & to monitor long-term trends (5-25 m)	Macro-invertebrates & macro-algal spp. in random quadrats from Tatoosh Isl. to Neah Bay area	Michael Kenner, UCSC, Santa Cruz CA (831-459-3244) or Ed Bowlby, OCNMS (360-457-6622, x17),
Subtidal Habitats & Fauna	Develop baseline data for habitat characterization & to monitor long-term trends (5-25 m)	Macro-invertebrates & macro algal spp. along permanent video transects & quadrats, Cape Flattery to Destruction Isl.	Rikk Kvitek, California State University at Monterey Bay (831-582-3529) or Ed Bowlby, OCNMS (360-457-6622, x17)
Intertidal Habitats & Fauna	Long-term monitoring to detect habitat trends	Macro-invertebrates and macro algal spp. along intertidal transects, Cape Flattery to Kalaloch	Steve Fradkin, ONP (360-928-9612)

Intertidal Habitats & Fauna	Develop baseline data for habitat characterization & to monitor long-term trends	On-site inventory of geomorphological characteristics & biota, Neah Bay to Copalis	Carl Schoch, PWSC (907-235-4799, x2) or Liam Antrim, OCNMS (360-457-6622, x16)
Intertidal Habitats & Fauna	Develop baseline data for habitat characterization & to monitor long-term trends	Contracted aerial video coverages of outer coast	Ken Warheit, Wash. Dept. Fish & Wildlife, Habitat Management/Spill Response or Liam Antrim, OCNMS (360-457-6622, x16)
Intertidal Habitats & Fauna	Long-term ecological interactions between macro-invertebrates, algae, & physical environment	Transects and quadrats on Tatoosh Island and Makah Bay	Bob Paine, Dept. Zoology, Univ. Washington or Cathy Pfeister, UC (773-834-0071)
Intertidal Invertebrates & Algae	Sea Grant Biotechnology Project to develop an integrated molecular biomarker system to assess & compare the health of aquatic life in relation to natural & human-induced stressors	Field collection of intertidal invertebrates & algae across gradients of natural stress (wave action) & pollution at sites from the outer coast & through Puget Sound, along with lab exposure tests with specific toxicants. A series of molecular-level biomarkers is used to examine responses.	Mary Sue Brancato, OCNMS (360/457-6622,x20) or Craig Downs, EnVirtue (540-723-0597); also, NCCOS/CCEHBR, Univ. of Charleston SC, Parametrix.
Intertidal	Studies of patterns, processes, and the mechanics of community distributions over multiple scales of space and time	Intertidal monitoring for Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)	Maria Kavanaugh, OSU (541-737-5359)
Invasive species	Develop baseline on nearshore invasive species	Used team of specialist for Rapid Assessment protocol to detect macroinvertebrates and macroalgae alien species	Mary Sue Brancato, OCNMS (360-457-6622,x20)

Invasive species	Detection of invasive larval arrival	Deploy nearshore plates to detect larval settlement	Catherine de Rivera, Smithsonian (619-294 3007)
Kelp	Monitor long-term trends in kelp canopy cover in relation to other ecological factors & components	Aerial infrared photography, digitized to GIS	Ed Bowlby, OCNMS, (360-457-6622, x17), Helen Berry, WDNR, Div. of Aquatic Resources (360-902-1052), or Bob VanWagen, Ecoscan (831-728-5900)
Nearshore and shelf currents	Monitor long-term trends in currents in relation to biological communities & oil spill scenarios	Moored current buoys and ADCP data via shipboard transects	Barbara Hickey, School of Oceanography, Univ. Washington (206-543-4737)
Green Crab/Invasive Species	To evaluate the spread & ecological effects of non-indigenous populations of the green crab (<i>Carcinus maenas</i>) along the WA coast	State & volunteer surveys of south side of Strait of Juan de Fuca to Neah Bay, to monitor for incidence of invading crabs	Mary Sue Brancato, OCNMS (360/457-6622,x20) Partners include WDFW & Makah Tribe.
Harmful Algal Blooms	ORHAB Washington HAB Monitoring Study (identification & interpretation of bloom events from satellite imagery)	Analysis of chlorophyll & sea-surface temperature imagery of sanctuary waters, and examination of associations of blooms with <i>Pseudo-nitzschia</i> and domoic acid patterns	Rick Stumpf, NOAA/NCCOS/CCMA, 301/713-3028
Harmful Algal Blooms	Determine phytoplankton species associations with biotoxin loads appearing in shellfish	Phytoplankton collections for species determination, Cape Flattery to Grays Harbor, as part of Olympic Region Harmful Algal Bloom (ORHAB) program	Vera Trainer, NMFS (206-860-6788)

Harmful Algal Blooms	Investigation of offshore physical and biological conditions to predict toxic bloom events	Oceanographic collections and drifter deployment to model Juan de Fuca Eddy as part of Ecology of Harmful Algal Bloom (ECOHAB) program	Barbara Hickey, School of Oceanography, Univ. Washington (206-543-4737) or Vera Trainer, NMFS (206-860-6788)
Juvenile Rockfish	Dependence of juvenile rockfish on drifting kelp mats as temporary refugia	Collections via boat offshore of Olympic Coast, out to 20 miles	Ray Buckley, WDFW (360-902-2828)
Sea Otters	Sea Otter Contaminant Study (baseline study of health of sea otters)	Live capturing of animals for blood & biopsy sampling & physical examination of health.	OCNMS (Mary Sue Brancato or Ed Bowlby, 360/457-6622), or Jay Davis, USFWS (360-753-9568)
Sea Otters	WA sea otter surveys to monitor distribution and abundance patterns	Annual population surveys using aircraft & shore-based observations	Steve Jeffries, WDFW (253-589-7235) or Ed Bowlby, OCNMS (360/457-6622, x17)
Pinniped haulouts	Monitor distribution & abundance trends of seals and sea lions	Annual & seasonal aerial surveys	Steve Jeffries, WDFW (253-589-7235) or Harriet Huber, NMFS (206-526-6433)
Marine mammals	Surveys of offshore cetacean and pinniped populations & habitat use patterns	Ship-based surveys using line-transect methodology	Ed Bowlby, OCNMS, (360/457-6622, x17) or John Calambokidis, Cascadia Research (360-943-7325)
Birds	Coastal Observation & Seabird Survey Team (COASST) efforts to track deposition of beached bird carcasses, as a means of detecting unusual events & monitoring status & trends in coastal bird populations.	Volunteer monthly surveys of beached bird carcasses (& marine mammal strandings to some degree)	Mary Sue Brancato, OCNMS (360/457-6622,x20) or Todd Hass, UW (206-221-6893)

Birds	Determine at-sea distribution of seabirds as an indication of habitat use in nearshore areas	Boat observational transects conducted from Straits of Juan de Fuca to Columbia River	Chris Thompson, Wash. Dept. Fish & Wildlife (425-775-1311, x 109)
Birds	Determine reproductive success of nesting seabird colonies	Observations from Tatoosh Island	Julia Parrish, Univ. Wash., Dept. Zoology (206-221-5787)
Seabirds & Raptors	Determine reproductive success of nesting seabird colonies & raptor nest sites	Annual aerial surveys of Refuge Islands & coast nesting areas	Ulrich Wilson, USFWS Washington Maritime National Wildlife Refuge Complex (360-457-8792)
Raptors	Determine reproductive success of nesting raptors	Aerial surveys of nest sites along WA coast	Shelley Hall, ONP (360-457-8792), Shelly Ament & Anita McMillan, WDFW
Birds	Determine at-sea distribution of seabirds as an indication of habitat use	Ship-based strip transects along continental shelf	Barbara Blackie, OCNMS (360-457-6622, x26)
Cetaceans	Determine trends in abundance & habitat use patterns for gray, humpback & orca whales	At-sea surveys for photo identifications survey, Cape Flattery to Grays Harbor	John Calambokidis, Cascadia Research Collective (360-943-7325)